

Air pollution : → The atmospheric air contains about 79% of nitrogen and 21% of oxygen and the negligible traces of other sixteen elements such as carbon dioxide, methane, carbon monoxide, ammonia, sulphur dioxide, etc are found, which have practically no adverse effect. This air is considered as pure or healthy and is always desirable for human life, animal life and plant life. But due to various factors the balance of nitrogen and oxygen disturbed gradually and is causing adverse effects on human health, animal life, plant life and other materials of the universe.

So, the accumulation of destructive elements in the air from the natural or unnatural sources is termed as air pollution.

Causes of air pollution : → The following are the causes of air pollution.

- (1) Increase in population and traffic.
- (2) Development of industries.
- (3) Development of automobile engineering.
- (4) Development of agriculture.
- (5) World wide arms race.
- (6) Thermal and nuclear power generation.

(1) Increase in Population →

Due to the increase in population, the residential areas of a town or city are being enlarged by destroying the forest areas, trees, jungles etc. which have the property of absorbing carbon dioxide and releasing oxygen.

Due to the growth in population the systems of ignition have also become a matter of grave concern in a town or city. Again the ~~manufacture~~ manufacturing units of house construction materials such as bricks, cement, stone chips etc. impart much pollutants in air.

(2.) Development of Industries →

The development of industries such as fertilizer industry, chemical industry, metallurgical industry, petroleum industry, tanning industry, paper industry etc. discharge poisonous gases and waste products.

(3) Development of Automobile Engineering →

Due to the development of automobile engineering, the vehicles of petrol and diesel engines are going on increasing in urban areas. The towns and cities are

crowded with buses, minibuses, cars, taxies etc. which are releasing much carbon monoxide in the air regularly.

(4) Development of Agriculture →

Due to the development of agriculture, improving the yield of crop has become easier. So, the application of chemical ~~pesti~~ fertilizer and insecticides have become a trend. Such things are also responsible for air pollution.

(5) World wide Arms Race → All the

countries in the world have a tendency to obtain more power ~~than~~ than the others by creating nuclear weapons and other explosives. The nuclear explosions are carried out on the surface of the purpose. The radioactive substances from such explosions are polluting the atmospheric air.

(6) Thermal and Nuclear Power Generation →

Due to the development of civilisation, the demand of electric power has increased many folds for running refrigerators, televisions, sets, washing machines, pump sets, lights, fans, etc.

To meet the excessive demand of power, the thermal and nuclear power generation plants have become an urgent need. The fly ashes and radioactive ashes generated from such plants are polluting the atmosphere air.

Different forms of air Pollutants: →

- (i) Smoke → It is produced chiefly due to the incomplete combustion of fuel such as coal, oil, petroleum etc. It contains carbon monoxide, carbon dioxide etc.
- (ii) Dust → It is finely divided powder-like matters generated by crushing or grinding of stones, ~~disintegration~~ disintegration of stones or other inorganic substances.
- (iii) Gases. → These are formed by the decomposition of organic matters or burning of fuels.
- (iv) Aerosol → The dispersion of microscopic solids or liquids in the atmosphere is termed as aerosol.
- (v) Particulate ~~matter~~ matter; → The matter which is generated from the sources such as industries, power generation plants, road-way dust etc and exist in atmosphere in suspension is known as particulate.
- (vi) Pollen → The fertilizing or reproductive matters of flowers to form seeds is known as pollen. The pollen can float in air or it can be transferred from flowers to flower by bees or butterflies.
- (vii) Sulphur Dioxide (SO_2) → It is generated from thermal power plants

petroleum industries, oil refineries, acid manufacturing plants etc. It causes respiratory diseases, irritation of throat and eyes etc.

(viii) Hydrogen sulphide (H_2S) → It is generated from sewage treatment plants, tanning industries, dye manufacturing etc. It causes ~~irritation~~ irritation and disorder of respiratory organ etc.

(ix) Nitrogen Oxide (NO) and Nitrogen Dioxide (NO_2) → These are generated from explosive manufacturing industry, automobile workshop, acid manufacturing plant etc. It causes bronchitis and oedema of lungs etc.

(X) Hydrogen Fluoride (HF) → It is generated from chemical industry, fertilizer industry, aluminium industry etc. It causes skin diseases and bone fluorosis etc.

(XI) Hydrogen Peroxide (H_2O_2) → It is generated from photochemical smog products. It causes lung irritation.

(XII) Carbon monoxide (CO) and Carbon Dioxide (CO_2) → It is generated from automobile exhaust, blast furnace, fuel gases etc. It is a poisonous gas and causes damage to the respiratory organ.

(XIII) Hydrocarbon → It is generated from automobile exhaust. It causes disease of respiratory organ.

(XIV) Arsenic → It is generated from detergents, pesticides etc. It causes skin diseases.

Sources of air pollution: → the sources of air pollution may be classified in two groups:

(1) Natural sources (2) Man made sources.

(1) (i) Atmospheric Reactions: → In the atmosphere, different types of chemical reactions always going on. In the lower atmosphere, the gases or vapours ~~are~~ are always converted into solids or liquids by condensation or oxidation. In upper atmosphere, the photo-chemical reactions are going on by the absorption of ultra-violet solar radiation. It breaks the complex molecules of organic matters. The products of atmospheric reactions come down to earth by rain, snowfall etc.

(ii) Dust and Aerogol → The dust and aerogol which are present in atmosphere consist of salt particles from sea water, air-borne particles, bacteria, etc. The particles remain in suspension in air.

(iii) ~~Microorganisms~~ → These are in the form of algae, fungi, bacteria, yeast etc. These organism can be transported by wind to far distances and can affect plants, animals and human beings.

(iv) Pollen → These may enter the atmosphere from the ~~the~~ flowers of trees, grasses and weeds and may be transported from place to place by wind.

(v) Radioactive substances → The

radioactivity of the atmosphere is caused by the radioactivity of the atmosphere is caused by the radioactive minerals present in the crust of the earth and the action of cosmic rays. The radioactive substances such as radium, Uranium, thorium, etc are responsible for imparting the radioactivity of air.

(2) man-made sources : → The following are the man-made sources of air pollution:

(i) Combustion of fuel → In domestic areas, the burning of coal, wood, oil and LPG forms harmful gases which pollute the air.

(ii) Thermal and Nuclear Power Plants: → The thermal power plants contribute radioactive fly ashes to the atmospheric air.

(iii) Industries → The industries like iron and steel manufacturing, oil refinery, chemical factories, petro-chemical plants, pulp and paper, etc cause serious air pollution. The smelting and refining of non-ferrous metals also impart much air pollutants.

(iv) Vehicular Pollution : → The towns and cities are crowded with trucks, buses, minibuses, taxies, etc. which exhaust carbon monoxide in large scale. This gas is very dangerous to human health.

(v) Construction materials → The manufacture of bricks, cement, stone

chips etc. pollute the atmosphere by discharging smoke, gases and dusts.

(vi) System of Sanitation → The unscientific disposed of garbage produces fuel gases, bad odour and insanitary condition. In towns where the conservancy system is followed, the system of disposal of night soil produces foul gases, fly nuisance etc.

(vii) Nuclear Combustion → The experimental combustion of nuclear weapons pollutes the atmosphere by radioactive centre, also develop radioactive substances which pollute the atmosphere.

Effects of Air pollution:

The following are the effects of air pollution:

(i) Effect on human Health: →

The inhalation of different gases causes various effects on the human health as listed in the table —

Table

Air pollutants	Effect on human health
(a) Sulphur dioxide	It causes suffocation, respiratory diseases, irritation of eyes and throat.
(b) Hydrogen oxide	Danger of respirating paralysis.
(c) Nitrogen oxide	It causes bronchitis, oedema of lungs.
(d) Hydrogen fluoride	It causes skin diseases, bone fluorosis
(e) Carbon monoxide	It causes lungs diseases and slow poisoning leading to death.
(f) Oxidants	It causes lungs diseases

(g) Arsenic

It causes skin disease

(H) Effect on material": →

Some of the harmful effects of air pollution has on various material are as follows: →

(i) It causes deterioration of building material

(ii) It causes corrosion and incrustation of metals.

(iii) It causes discolouration of paints, cement colour etc.

(iv) It causes reduction of strength of materials.

(I) Effect on Vegetation: →

The concentration of nitrogen dioxide, sulphur dioxide and ozone may damage plants, vegetables, fruit trees and forest areas.

Some of the typical effects on vegetation are as follows:→

- (i) Plants may be dried up, the yield of crop may decrease the quality of crops may decline or may be affected by diseases.
- (ii) The growth of vegetables may stop, the quality may be inferior or may be affected by diseases.
- (iii) The quality of fruits may become inferior or the quantity may also decrease.
- (iv) The forest area may get destroyed gradually.

The growth of trees may become stunted or may dry up completely.

The End

Different methods of controlling air pollution: →

The following steps should be taken to control air pollution:

(1.) Control by zoning: → The area of the town or city should be divided into different zones such as residential zone, industrial zone, trade zones etc. The industrial zone should be such that the future development will follow the rules and provisions made for that zone.

(2.) Control by Afforestation → It is found that the plants can reduce air pollution to a great extent. So, plantation of trees should be encouraged all around the town or city. New forest area should be developed. Trees should be planted at parks and public places.

(3.) Control by Vehicle Rules: → The "vehicle act" be strictly followed. The design of vehicles should be such that complete combustion of fuel takes place in the engine. The exhaust constituents of the motor vehicles should be within the prescribed safety limit.

(4.) Control by Increasing the Height of chimney: → The height of chimneys of thermal plants, nuclear plant, brick

manufacturing plants etc should be increased up to the permissible limit so that the smoke, fly ash or rubbish does not spread over the residential area.

(5) Control by Ventilation : → Suitable ventilation system should be provided in the kitchen of every house so that the gases produced by burning of wood, coal, oil etc. may be exhausted very quickly

(6) Control by mechanical Device : →

Any one of the following devices should be adopted in industry for controlling the atmospheric pollution

(a) cyclone collectors

(b) Bag filters or fabric filters

(c) cyclonic scrubbers

(d) Venturi scrubbers.

Distinguish between

(a) Primary and secondary air pollutants →

Air pollutants can also be broadly classified into general groups - primary air pollutants and secondary air pollutants.

Primary air pollutants are those emitted directly from identifiable sources.

Examples of Primary air pollutants

(1) Finer particles (less than 100 μm in diameter)

(2) Coarse particles (~~less~~ than 100 μm in diameter)
greater

(3) Sulphur compounds

(4) Oxides of Nitrogen

(5) Carbon monoxide (6) Halogen compounds

(7) Organic compounds (8) Radioactive compounds

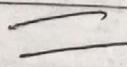
Finer aerosols include particles of metal, carbon, tar, resin, pollen, bacteria etc.

Secondary air pollutants are those which are produced in the air by the interaction with normal atmospheric constituents, with or without photoactivation.

Examples of Secondary air pollutants:-

(1) Ozone (2) Formaldehyde (3) PAN (Peroxy acetyl nitrate) (4) Photochemical smog Smog

(5) Formation of acid mist (H_2SO_4) due to reaction of sulphur dioxide and dissolved oxygen, when water droplets are present in the atmosphere.



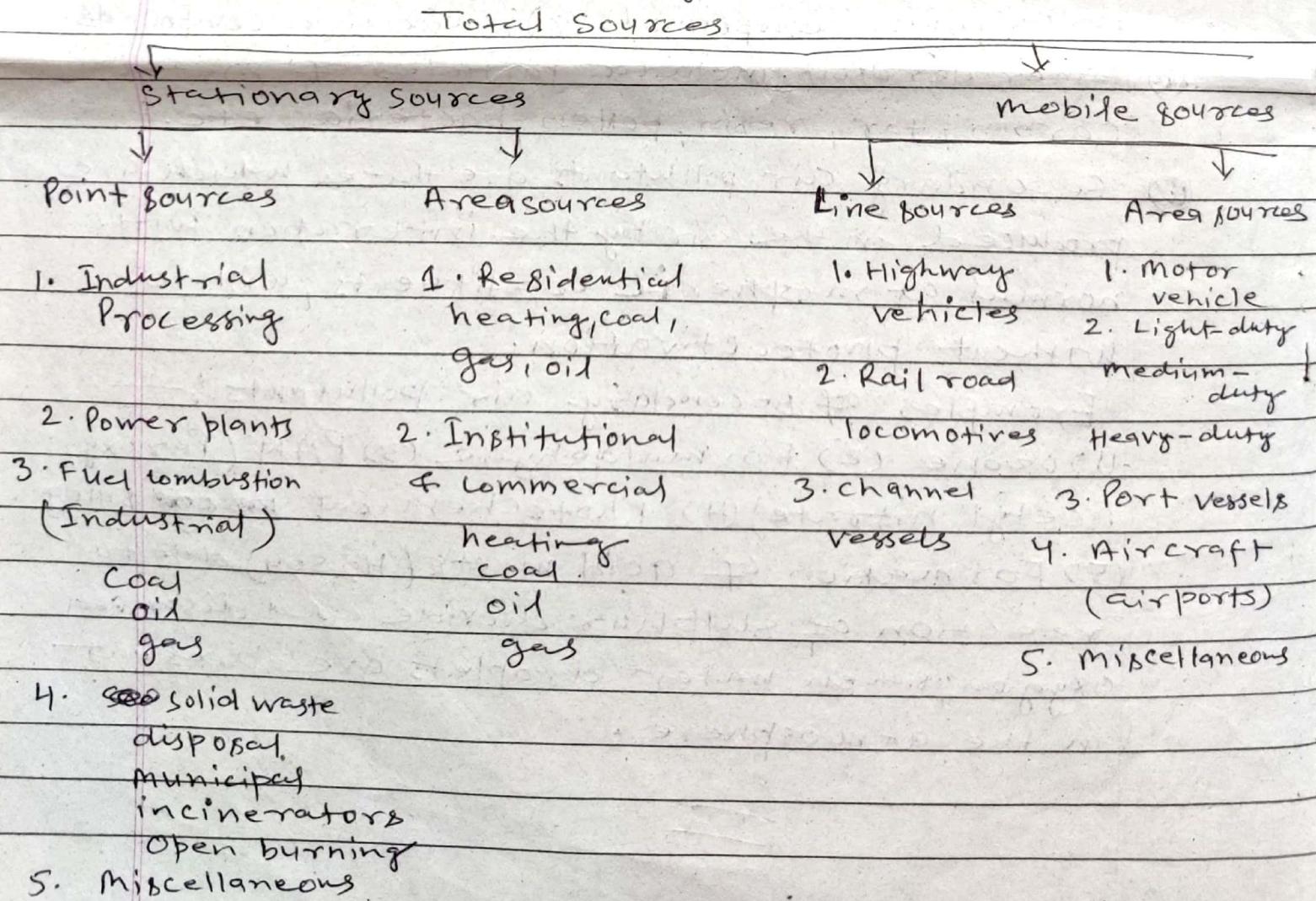
Distinguish between stationary and mobile sources of air pollutants →

Emissions (air pollutants) may be classified by sources, as stationary or mobile. Another method of classifying emission sources is by:-

- (1) Point sources (large stationary sources)
- (2) Area sources (small stationary sources and mobile sources with indefinite routes)
- (3) Line sources (mobile sources with definite routes)

Table 1 gives a picture of emission inventory source classification.

Emission Inventory Source Classification



Effects of air pollutants with respect
to (i) cigarette smoking (ii) domestic pollution

(A) Effects of exposure of animals to ionising radiation: → Radioactive fallout from nuclear bomb testing in the atmosphere results in ionising radiation, which has biological effects. The effects of radiation on animals are qualitatively similar to those in human beings. The effects may be either acute ~~acute~~ radiation effect or delayed long-term effect.

Symptoms of acute radiation injury develop within a period of hours to weeks, following exposure. Only fallout occurring close to the nuclear bombs test site can produce acute radiation effects, because of the high degree of radiation received by the animals body.

The long term effects are:-

- (1) Cancer (including leukaemia)
- (2) Shortening of life span.
- (3) Genetic or mutation effect.

For manifestation of these effects, it generally takes several years, even generations in case of genetic changes.

(B) Relation of air pollution Effects to other exposures →

(i) Cigarette smoking: → The dose of pollutants from cigarette smoking is high and intermittent relative to that from community air pollution.

For example, 400 ppm (400mg/m³) of carbon monoxide for five minutes with frequent repetition may

be a representative cigarette smoking dose, while from 10-30 ppm ($11-33 \text{ mg/m}^3$) of carbon monoxide for 4-8 hours may represent a frequent community air pollution exposure.

Each of these alone may result in inactivation of up to 5% of the haemoglobin.

Together, of course, the effect will be more.

Similarly, the exposure to oxides of nitrogen present in cigarette smoke is about 100 ppm, whereas the average exposure to heavy air pollution over periods of about an hour will not exceed about 1.5 ppm (2.8 mg/m^3).

But, as pointed out earlier, cigarettes to which the body is exposed include carcinogens, aldehydes, hydrogen cyanide, lead etc.

The effects ~~of~~ of cigarette smoking are more important than effects of air pollution, as far as causing lung cancer or chronic pulmonary disease in the whole population is concerned.

But, when both factors are present, they naturally have more than additive effect.

This means that cigarette smokers are at unusual risk, if they live in areas with substantial air pollution and that the effects of ~~the~~ air pollution on chronic pulmonary diseases are more likely to occur in cigarette smokers.

(ii) Domestic pollution: → cooking and home heating appliances can generate a group of air pollutants (carbon monoxide, sulphur oxides, oxides of nitrogen, soot and oily aerosols) whose health effects have commonly been overlooked.

During periods of still weather and low winds, the dispersal of such domestic pollutants will be impaired. Generally, oxidants are about half as concentrated within buildings in polluted areas as they are outside, but carbon monoxide and nitric oxide are likely to occur at similar concentrations indoors and outdoors. Hence, if smoking or cooking occurs indoors, exposures to carbon monoxide and nitrogen oxides may be quite high.

Air quality standards

Air quality Standards → Each pollutant, present in air, has a threshold limit value (TLV) which, if exceeded, causes public health hazards. Table 1 gives a list of typical pollutants with their threshold limits (TLV). For factory workers TLV sets the limit of exposure for 40-hours week (8 hours a day) without adverse effects. These TLV values are determined mainly by experiments on animals.

Table 1. Threshold limit values(TLV) for some common pollutants (gases and vapours)

Pollutant	Threshold limit ppm	Values mg/m ³
Acetone	750	1780
Ammonia	25	18
Arsenic	0.2 - 0.5	—
Benzene	10	20
Cadmium	—	0.05
Carbon dioxide	5000	9000
Carbon monoxide	50	50
Carbon tetrachloride	5	30
Chlorine	10	30
Chloroform	10	50
Hydrogen chloride	5	7
Hydrogen sulphide	10	14
Lead	—	0.2
Nitric oxide	25	30
Ozone	0.1	0.2
Sulphur dioxide	2.0	5.0
Vinyl chloride	5	10

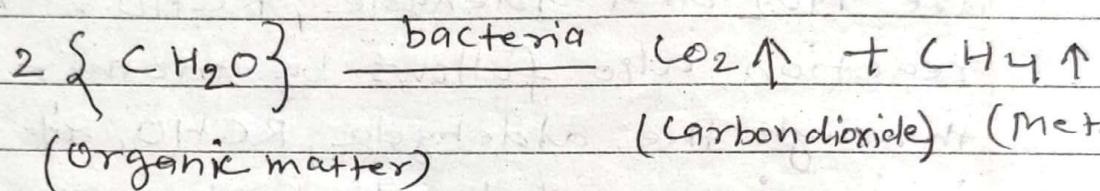
Hydrocarbons and Photochemical smog

Hydrocarbons and Photochemical smog →

Natural processes, particularly trees, emit large quantities of hydrocarbons in air.

Methane, CH_4 is a major hydrocarbon.

It is generated in large quantities by bacteria formed by anaerobic decomposition of organic matter in water sediments and soil.



Domestic animals (cattle, buffaloes, etc)

contribute about 85 million tons of methane to the atmosphere each year.

Automobiles are significant sources of hydrocarbons.

In presence of ozone, carbon monoxide, nitrogen oxides and hydrocarbon participate in photochemical reactions (in presence of sunlight). A chain reaction proceeds in which the free radical RCH_2 is generated in the first step. Other free radicals which are formed are RCH_2O_2 in the second step by reaction with oxygen,

~~RCH_2O_2~~ RCH_2O , RCH_2O in the third step by reaction with oxygen, a stable aldehyde RCHO is another product at this stage, HO is formed in fifth step by reaction with

nitric oxide (nitrogen dioxide is another product here), and finally, the starting free radical RCH_2 is regenerated by reaction with hydrocarbon, RCH_3 thereby ~~sustains~~ sustaining the chain reaction.

The harmful products in the chain reaction are NO_2 and aldehyde, RCHO . A side reaction also follows by another route through the aldehyde, RCHO , it gives an injuries end product, peroxy acyl nitrate (PAN) which is a strong eye irritant. These reactions lead to photochemical ~~smog~~ smog formation, which is characterized by brown hazy fumes which irritate the eyes and lungs and also cause serious damage to plants.

Photochemical smog occurs in coastal cities in winter climate, e.g. in Los Angeles, USA which have the heaviest vehicular traffic.

Meteorology & Air Pollution

Meteorology and Air Pollution: → Air Pollution, one of the man-made activities, has impact on meteorology i.e. the science of atmospheric phenomenon. Meteorology is based on the physical parameters such as temperature, wind, moisture and movement of air masses in the atmosphere. It is also affected by the chemical properties of the atmosphere and the chemical reactions going on in the atmosphere.

The air pollutants get dispersed in the atmosphere depending on the patterns of air circulation. In this context temperature inversion plays an important role. It occurs when a warm air mass moves above a cold air mass resulting in air stagnation of the latter (cold air) in which air pollutants get trapped. The air above the ground becomes polluted. This happens when warm air blows over a mountain range and over cool air on the other side of the range. Such a phenomenon is observed in Denver, USA on the east of Rocky mountains.

Human activities are partly responsible for changing the meteorology of the earth.

Those activities are

- (1) Deforestation and loss of forest cover.
- (2) shifting of surface water and groundwater in large amounts
- (3) Release of heat from power plants.
- (4) Emission of particles and trace gases into the atmosphere
- (5) Release of carbon dioxide into the atmosphere by combustion of fossil fuels
- (6) Emission from transport system into the lower and upper atmosphere.

The loading of particulate matter into the atmosphere influences the climate. It has been shown in Table 1

World wide Addition of particulate matter to the Atmosphere (in million Tons)

Table - 1

Particulate matter	Annual Production (million tons)	
	Natural source	Man-made sources
Total Particulates		
Total Particles	800 - 2000	200 - 450
Dust and smoke	—	10 - 90
Salt, forest fires	450 - 1000	—
Sulphate	130 - 200	130 - 200
Nitrate	30 - 35	140 - 700
Hydrocarbons	15 - 20	75 - 200

that each year natural sources are injecting about 800-2000 millions tons while man-made sources about 200-400 millions tons of particles in the atmosphere.

As already discussed, particle induce cloud formation and rainfall. It has been calculated as an approximation that if the particle loading increases by 50 percent, the average temperature of the earth will decrease by about 0.5°C to 1°C due to particle - induced cloud formation.

This partly counterbalances the temperature rise due to Greenhouse Effect.

EL Nino

EL Nino → Green house effect is an atmospheric warming phenomenon while EL Nino is an ocean warming phenomena. EL Nino is a Spanish term for the Christ child as it starts in December in South American coast but it affects over half the globe.

Under normal conditions the water of the Eastern Pacific off Ecuador, Peru and Chile is cooler by 10°C than the waters of the Western Pacific. This promotes fisheries along the Eastern Pacific coast since cold waters, rich in nutrients, spring from the deep layers of the ocean. The trade winds blow along the equator from south east Pacific towards west pushing warm waters out to the ocean. But once every three to five years the trade winds reverse their direction, i.e. from west to east thereby pushing warm waters to the east. As a result, the Eastern ~~Pacific~~ Pacific water warms up by about 4°C (24°C to 28°C) which ~~disrupts~~ disrupts the anchovy fishery, key to the Peruvian economy. This happens when El Nino appears. It not only kills fish but warms the air which lowers the atmospheric pressure and sparks storms and heavy rainfall along Chile coast and spreading up to Southern California (USA).

In 1982 El Nino raised sand storms in Australia, cyclone in Tahiti, caused droughts in Africa and floods along the California coast in U.S.A. Recently in 1998 El Nino activity has been felt all over the world. On the east coast of USA, winter was missing in January-February and in the west coast there was record rainfall in ~~some~~ 100 years of US history. Research is on to understand the science of El Nino so that it can be forecast and advance warning signal sent to the regions where lives and properties can be saved in time.

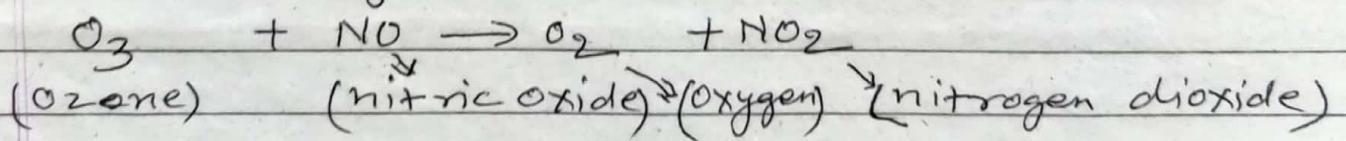
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Ozone Hole

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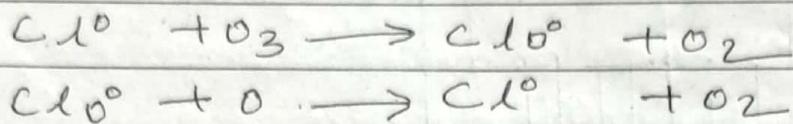
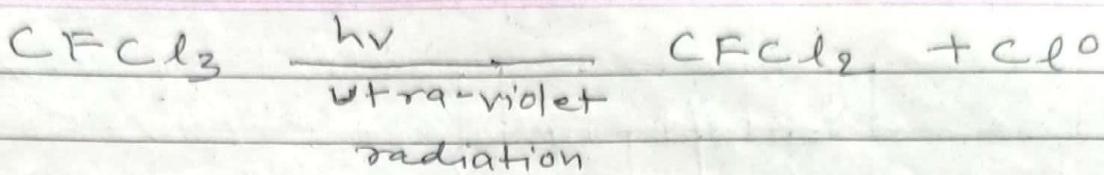
Ozone Hole → In the stratosphere, the second region of the atmosphere, Ozone is present in small quantities but it is protective shield for the earth. Ozone strongly absorb ultraviolet radiation from the sun (295 - 320nm) which is injurious for life on earth. Thus it protects living species on earth. But recent human activities have injected some dangerous chemicals in the stratosphere which consume ozone and reduce its concentration. This is the phenomenon of ozone hole in the stratosphere.

Exhaust gases from jet aircrafts and artificial satellites discharge nitric oxide (NO), nitrogen dioxide (NO_2), etc. which immediately react with ozone.



Chlorofluorocarbons (CFC) are used as coolants in refrigerators and air conditioners. These slowly pass from troposphere and once there, they stay for 100 years.

In presence of ultraviolet radiation (200nm) from the sun, CFC breaks up into chlorine free radical ~~radical~~ (Cl) which readily consumes ozone.



The free radical (Cl°) is regenerated and continues the chain reaction. It is estimated that one molecule of CFC consumes one lakh molecules of ozone. The damage by CFC continues for 100 years. Even if CFC production is stopped now all over the world, the CFC that is already there in the stratosphere will continue to damage the ozone layer for the next 100 years.

In 1979 ozone hole was observed in the sky over ~~Antarctica~~ Antarctica. Here ozone layer thickness was reduced by 30 percent. Later on ozone hole was discovered in the sky over the thickly populated northern hemisphere. Here in winter ozone thickness was reduced by 4 percent and in summer by 1 percent.

Ozone hole allows passage of ~~increased~~ ultra-violet radiation to earth where it causes skin cancer, eye sight defect, genetic disorder etc. in the biosphere (man, animals and plant).

In Europe and USA there is an increase in the ~~cases~~ cases of skin cancer among people while some million people are suffering from eye ~~contract~~ cataract. In Montreal conference (Montreal protocol, 1987) and London conference (1992) it was decided that the developed countries would totally ban CFC production by ~~around~~ 2000 and the developing countries by 2010 AD. But as stated above, even after the ban is enforced the CFC and Cl_2 shall continue their havoc for another 100 years. Researches are on for development of CFC-substitutes as coolants for refrigerators and air-conditioners.

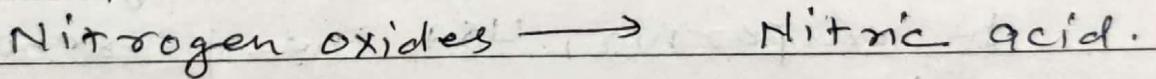
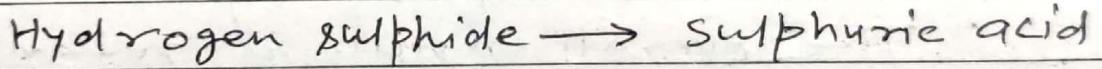
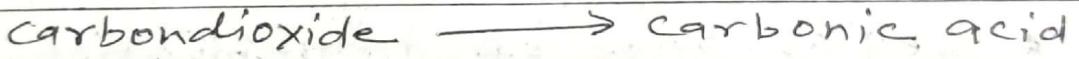
Air Pollution and Biosphere

Air pollution and Biosphere: →

Air pollutants are present largely in the troposphere and lower stratosphere.

The ground air, 1-100 metres high, is very much polluted in urban and industrial areas. Some pollutants are absorbed on vegetation, buildings and water surfaces.

The primary pollutants, discharged into the atmosphere, undergo chemical changes in presence of water vapour, oxygen and solar ultra-violet radiation and produce secondary pollutants.



These pollutants (secondary) have harmful effects on soil, vegetation, crops, animals, men and materials.

Plants are affected both by gaseous pollutants and by particulates deposited on soil. Acid rain over a period of time tends to reduce the soil pH ($= \log H^+$ i.e. negative logarithm of hydrogen ion concentration which is

an index of acidity, alkalinity or neutrality) and renders it acidic and soil in industrial areas makes the soil unsuitable for growth of plants.

Some plants are very sensitive to traces of toxic metals as the latter inhibit the action of some plant enzymes.

Particulates such as dust and soot are deposited on plant leaves and block the stomata (opening in the epidermis of plants). This restricts the absorption of carbon dioxide and hence reduce the rate of photosynthesis as well as rate of transpiration.

The overall result is retarded growth of plants and decreased yield of crops.

In California, USA the presence of sulphur dioxide in air and metallic pollutants in soil killed vegetation in an area of 300 km^2 and affected growth on a further 350 km^2 of land. In Leeds, UK. there was drastic decrease in growth of lettuce and radish in heavily polluted industrial areas compared to less polluted areas of the city.

Ozone and peroxyacetyl nitrate (PAN) (in photochemical smog) are oxidising

agents which attack plants by oxidising their sulphhydryl (-SH) groups of proteins into disulphides. This leads to inhibition of individual enzyme activity. They also affect photosynthesis by plants.

Cattle are affected by air pollution, particularly under smog conditions. They develop breathing troubles, ~~loss~~ loss of appetite and show low ~~milk~~ milk yield while many of them die.

Man has become the victim of air pollution. Thousands of chemicals pose the problems of health hazards during manufacture and handling. A typical list of 24 extremely hazardous substances in the atmosphere has been submitted by the United States Environmental Protection Agency (1973).

Acrylonitrile, Arsenic, Asbestos, Benzene, Beryllium, Cadmium, chlorinated solvents, ~~chlorofluorocarbons~~, chrysotile, coke oven emissions, ethylene oxide, ~~lead~~, lead, mercury, ozone, sulphur dioxide, vinyl chloride, Toxic waste disposal emission and leachates (washes)
etc.

Factors influencing atmospheric deterioration

Factors Influencing Atmospheric Deterioration:

There are four prime factors which influence the rate of attack of damaging pollutants. They are moisture, temperature, sunlight and air movement.

1. moisture → The presence of moisture in the atmosphere greatly helps the process of corrosion. Without moisture in the atmosphere, there would be little atmospheric corrosion, if any, even in the most severely polluted environments. In case of sulphur dioxide and various combinations of particulates, investigations have revealed that the rate of corrosion of metals will increase as relative humidity in the air increases.

2. Temperature → Temperature affects the rate of the chemical reaction and consequently it affects the rate of deterioration.

3. Sunlight → In addition to producing damaging agents such as ozone through a series of complex photochemical reactions in the atmosphere, sunlight can cause direct

deterioration of certain materials. But in cases of fading of certain dyes or rubber cracking, damage due to direct sunlight cannot always be distinguish from that caused by ozone.

4. Air movement → Wind direction is an important factor to be considered in places where deterioration is caused by pollutants released from nearby factories.

For example, damage to agricultural crops in the vicinity of factories. Similarly, wind speed is also an important factor in determining the impact of air pollutants on the receiving surfaces. Pollutants present in wind blowing at high speeds will have more abrasive effects and they may also be carried over long distances. Where leather bound books are stored, air movement is a critical factor when the air is contaminated by sulphur dioxide.

List the various economic losses due to air pollution.

Economic losses (material damage) → Various economic losses occur because of material damage due to air pollutants. Air pollution damages materials chiefly by corrosion of metals. The prime air pollutants responsible for metallic corrosion is sulphur dioxide. In the presence of oxygen, sulphur dioxide is slowly converted to sulphur trioxide, which in turn may react with the moisture in the air to form sulphuric acid. Deposition of this acid on the metal parts of building roofs, eaves, downspouts, and other metal equipment results in a considerable loss from atmospheric corrosion in most urban communities. Losses through atmospheric corrosion in New York city were estimated in 1955 as 6 million dollars per year. According to a survey conducted by the Smoke Nuisance Department of West Bengal, the financial loss due to corrosion in West Bengal is Rs 5 crore annually. This figure has been arrived at by a survey made in Greater Calcutta and the district of West Bengal for over five years. Carbon soot appears to accelerate the process of corrosion, probably because of the absorption or adsorption of the gaseous pollutants.

on the particulate matter. Other important variables are temperature and relative humidity. Metals adversely affected include steel, aluminium, copper, zinc and iron. The economic loss due to corrosion caused by polluted air must also take into consideration deterioration of objects like steel rails, steel tramway tracks, overhead wires, metal on bridges, electrical contacts, etc. Such costs can only be estimated and no definite figures are available. Also, additional costs of painting, replacement, and substitution would have to be considered in estimating the total economic loss due to corrosion because of direct and indirect effects. Various economic losses due to air pollution are as follows.

- (1) Building materials (2) paints (3) Textiles (4) Rubber
- (5) leather (6) paper glass and ceramics (8) Electronics industry (9) Laundering and Dry-cleaning
- (10) Vegetation (11) Intangible loss.

Air pollution damage to various materials

Materials	Principal air pollutants	Effects
Building materials Metals	SO ₂ , acid gases Particulates, particulates	Corrosion, spoilage of surface loss of metal, tarnishing.
Building materials	SO ₂ , acid gases, particulates	Discolouration, leaching
Paint	SO ₂ , H ₂ S	Discolouration
Textile dyes	SO ₂ , acid gasses and NO ₂ , ozone	Deterioration, reduced tensile strength and fading
Rubber	Oxidants, ozone	Cracking, weakening.
Leather	SO ₂ , acid gases	Disintegration, powdered surface
Paper	SO ₂ , acid gases	Embrittlement
Ceramics	Acid gases	Change in surface appearance